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like material after it has undergone the organic change and subsequent cleansing in the process of manufacture, which consists in subjecting the material to the action of a bath of a solution of chloride of zinc, or of chloride of zinc combined with glycerine or sugar-water.

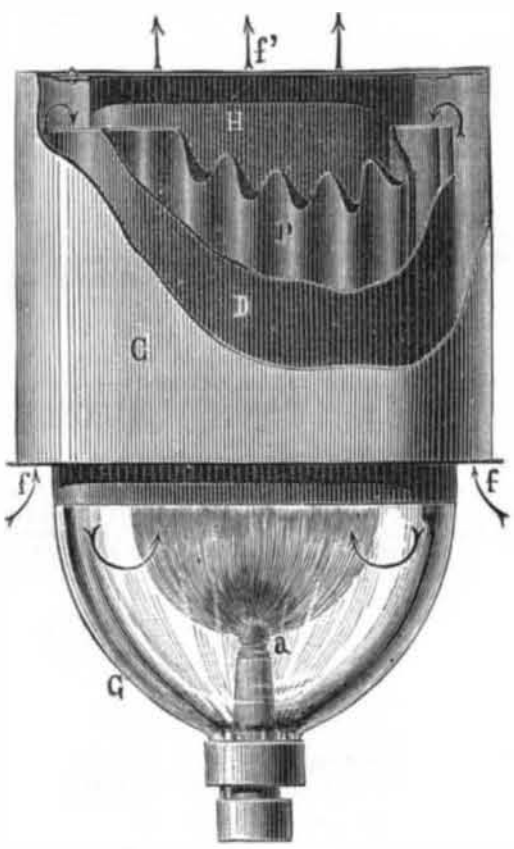
7. The herein-described bath for softening vulcanized fiber and such like material, which consists in the combination of a solution of chloride of zinc and glycerine or sugar-water.

DELMAS' HOT AIR BURNER.

THE Delmas burner has been the object of a patient study, with a view of determining the most favorable conditions for a perfect utilization of gas. It consists of an ordinary cleft steatite jet-piece inclosed in an oval globe, G, in such a way that the air cannot enter beneath. This globe is only of the height of the flame, and supports the heating apparatus. This latter consists of a flattish central chimney, H, which is surrounded by a corrugated tube, P, designed to multiply the heating surface, and ending at half an inch from the top of the chimney. This tube itself is inclosed in a jacket, D, into the lower part of which the globe is so fitted as to prevent any ingress of air.

In order to prevent loss of heat through radiation, and to still further increase the heating of the air, the entire apparatus is inclosed in a third flattish tube, C, which projects one-third of an inch beyond the globe, and which supports a reflector of tin, opal, or other material.

Under such circumstances, the air, *f*, necessary for the perfect combustion of the gas, in order to reach the burner within the globe, is obliged to rise through the annular space between the tubes C and D to the top of the apparatus, from whence it descends through the corrugated tube, P, and receives, as it does so, from the sides of the latter, all the heat due to the escape of



DELMAS' HOT AIR BURNER.

the products of combustion, *f'*, through the chimney, H. The dimensions of the air passage and of those through which the products of combustion flow secure a combustion without draught and a flame of remarkable steadiness.

This apparatus, which is manufactured by Mr. Giroud, recommends itself by its extreme simplicity. It can be substituted for an ordinary burner without necessitating any change in the fixtures, and secures a great saving by consuming but 60 cubic inches per carcel.—*Revue Industrielle.*

ON A HYPERBOLAGRAPH.

By Mr. H. H. CUNNYNGHAME.

IT is not an unfrequent want to be able to find a rectangle of greatest or least area contained between a curve and rectangular co-ordinate axes. In several problems connected with motion and pressure in steam engines, this is useful, and even in political economy the graphic representation of monopoly curves depends on maxima and minima of this nature. For the solution of such problems, it is often very useful to be able to describe rectangular hyperbolas, and the author has devised a machine to effect this. It depends on a mathematical property of the rectangular hyperbola which he believes to be new, and which is as follows: From a fixed point let any line be drawn to meet a fixed line, and from the point of meeting draw a line perpendicular to the fixed line and equal in length to the first line. The locus of the extremity of the second line is a rectangular hyperbola, or if from a fixed point, O, a line, O P, be drawn to meet a fixed line in a point, P, and P Q be taken perpendicular to the fixed line, so that O P and O Q be constant, then again the locus of Q is a rectangular hyperbola. In the machine the latter construction is mechanically and continuously carried out. A pencil, whose point corresponds in position to the point, Q, slides along a rule which is carried across the paper always perpendicularly to the fixed line. A fine steel wire attached to the pencil passes once round a roller at P, and is then carried to and coiled round a similar one at 0. The use of a steel wire is a special feature of the apparatus, and has a great advantage over string, which, owing to the facility with which it stretches, cannot give good results. The finest wire should be used; it unrolls from the one roller as much as it laps over the other, and its use may be extended to nearly all curve-drawing machines.

CARDIAC PULMONIC BALANCE.—A CLINICAL STUDY.

By BENJAMIN WARD RICHARDSON, M.D.

THE motive powers of respiration and circulation, like other motive powers in nature, are derived from the two prime movers or forces, the attraction of the earth and the force of combustion. The air enters the lungs by the atmospheric pressure; in other words, by the attraction exerted upon the atmosphere by the earth; the blood moves and circulates through the vessels of the body by the force of combustion, the evolution of motion from matter during change of condition.

These two forces, these prime movers, always at work in the organism during its life, are each regulated by the specific mechanism of the respirating and the circulating apparatus.

The mind, receiving at first the external phenomena that are presented to it only, is wont to consider that the movements of the chest and of the heart represent the prime forces of life. This is not wonderful, for they seem as if they must be the prime forces. To the untaught in mechanism, the movement of the pendulum of the clock, or the balance wheel of the watch seems to be the prime movement of the machine. The educated, however, know that the prime force is in the weight or the mainspring, and that what seems to be the force is, after all, the mere regulating movement, the means invented by the maker to prevent the undue liberation of force. But we do not so easily divine—because we do not know so much about the animal machine—that the respirating and circulating movements are the precise natural counterparts of the regulating movements of the timepiece, and that they themselves, fed by a portion of the force they distribute or superintend, have no more means for generating force than have the parts that are under their governance.

Nevertheless, these facts are so; the movements observed in the chest and in the heart itself are but means to an end—means for the regulation of the prime animal force. Truly, by stopping the movements, we can stop the organic motions altogether; but when we stop the pendulum of a clock, we, in like manner, bring all the motion of the machine to a standstill.

By the regulating actions of the thorax and heart, nature conserves force, and gives it direction. She strikes a proportion between the amount of blood that shall come to the air surface of the lung and the amount of air that shall come to the blood surface, in given periods of time. By this arrangement the force itself is regulated at one of its sources, the amount of force liberated in the combustion of blood being determined by the combination of air with blood. The balance thus struck, during normal conditions, is refinedly accurate, the pressure of air and blood being equalized to the nicest degree. On this fineness of balance the continuity of the delicate lung structures, vesicular and capillary, altogether depends.

The natural formula of this balance may be thus expressed: In a given period of time, say one minute, the right side of the heart must so regulate the blood-pressure that there shall be the same pressure of blood on the capillary surface of the lung as there is pressure of air on the vesicular surface. In like manner, in the same time, the thoracic mechanism must so regulate the air pressure in the vesicles that there shall be the same pressure of air on the vesicular surface as there is pressure of blood on the capillary surface.

The balance thus required is regulated, not so much by the number of cardiac or thoracic movements, as by the force of the movements and their equality. But for this provision, every irregularity in the motion of the heart or of the thorax would be registered in the lung by lesion of structure. In the act of running this is well expressed. When a man commences to run, the heart invariably takes brief precedence of motion, and the sensation of breathlessness is the result. After a short time, if there be a good balance, the breathing movements come abreast of the cardiac, the breathlessness passes off, and the running is easily sustained until the force of combustion, the mainspring, fails. In short, for true disturbance of the balance on either the respirating or circulating side, there must necessarily be either direct mechanical obstruction or direct failure on one side.

DISTURBED BALANCE FROM MORBID CHANGES.

There are many accidents and many morbid conditions under which this balance, so nicely adjusted, is disturbed, with lesions of the cardiac pulmonic mechanism as the result. The lesions thus induced are of two kinds, varying simply according to the side on which the disruption of balance first takes place.

When in any case there is sudden obstruction to the column of air passing through the trachea, so that the respirating mechanism cannot bring a sufficient volume of air into the lung, the blood pressure remaining the same, there is at once congestion of lung with blood, and, according to the degree of obstruction, stasisof blood in the lung. If the tracheal obstruction be complete and instantaneous, the heart, it is true, may be suddenly paralyzed, and the congestion may be indifferently marked; but when there is time for continued action of the heart, even for a period of minutes, then there is congestion.

On the other hand, if the balance of power fail on the side of the circulation, the respirating action being continued, then there is undue injection of the lung tissue with air, rupture of vesicles, and emphysema.

Both of these positions admit of being rigorously demonstrated by direct experiment upon the inferior animals. Both are constantly demonstrated in disease of the human subject. Asphyxia by hanging, or by the exudation of plastic matter into the trachea or larynx, illustrates the first position; sudden deposition of fibrin in the right cavities of the heart, and gradual failure of the right side of the heart from degeneration of its walls, illustrate the second position.

These are common examples of break in the balance of the two mechanisms, but there are others not less important.

DISTURBED BALANCE FROM ATMOSPHERIC VARIATIONS.

Sudden exposure of the air surface of the lung to extreme cold may, and often does, break the balance on the respirating side. There is contraction of the air-passages, a rapid abstraction of caloric from blood, and a reduced oxidation of blood. On this, if the heart continue active, and the prime force of the circulation remain sufficiently long, there is, during reaction, extreme congestion, exudation, and what is called pneumonia, or congestive bronchitis.

In the opposite way, sudden exposure to heat leads to excessive action of the heart, and to a pressure of circulating blood which the respiration is unable to meet. The oxidation is intense; the venous blood becomes of arterial redness; there is no time for cooling on the respiratory surface, none on the cutaneous. The increment of temperature runs up with fatal rapidity, and the muscles are fixed, from this cause, in tetanic spasm.

I have seen a horse, ridden hard on a hot day, lose breathing power, while the circulation continued in full swing; and thereupon, with the balance broken on the pulmonic side, pass into as perfect tetanus as if it had taken strychnine, or had sustained a traumatic injury leading to tetanus.

Changes in the pressure of the air lead to broken balance on the pulmonic side when the pressure is reduced, on the cardiac side when the pressure is increased. The first of these events is witnessed in mountain climbing; the second in the coffer dam, when the workers are subjected to what has been called "caisson disease."

To some extent, and possibly to a greater extent than is generally recognized, the ordinary vibrations of atmospheric pressure produce disturbance of the cardiac pulmonic balance. In damp weather, with the pressure low, persons short of breath pant, in order to keep the breathing on a level with the circulation; while in cold, dry weather, with the pressure high, those who have feeble circulation have no sufficient power of circulation to sustain a level with the respiration.

In fact, by watching closely the influences of varying atmospheric pressures upon the cardiac pulmonic balance in the unhealthy from thoracic disease, it is not difficult to prognosticate each day from the barometer, thermometer, and hygrometer the general condition of the different classes of the afflicted.

EFFECT OF MENTAL AND PHYSICAL SHOCKS.

Sudden paralysis of the heart, as from mental emotion, severe pain, or physical shock, will break the balance on the circulating side. In cases of that most painful affection, cardiac apnœa, we see this effect of disturbed balance painfully demonstrated. The patient, with the respirating mechanism in full vigor, breathes into almost bloodless lungs with nearly certain disruption of structure more or less extended. In one case of sudden death from this affection, I found the bloodless lungs as white as milk, and so infiltrated with air as to distend the chest walls, and to resist being emptied of air by the firmest pressure of the hands.

Frequently repeated physical shocks lead to a disturbance of the balance which may become permanent in character. A youth was brought to me twenty years ago who had disturbed the balance by violent muscular exercise, and in whom the heart was so powerful and irritable, that the least excitement or exertion brought on an attack of breathlessness. By absolute rest for two years, with the body recumbent, the balance was fairly restored; but to the present day any exertion or excitement, in excess, leads to an attack of dyspnœa, which might easily be mistaken for pulmonic disease, having an organic seat in the pulmonary structure, if the original cause were not known.

In the asthmatic, slight causes, acting from either side and disturbing the balance, are often sufficient to provoke an acute asthmatic paroxysm. In these subjects the break leading to a paroxysm is often, perhaps most often, from the cardiac side.

EFFECTS OF VOLATILE FLUIDS.

The balance of the cardiac-pulmonic mechanism may be disturbed by the agency of various substances, vaporous and soluble, some of which we have in common use. I find that all volatile fluids which have a boiling-point as low or lower than the standard temperature of the blood, produce, when they are inhaled, obstruction in the respiratory process, and therewith extreme congestion of the lung, the pressure exerted by the blood current exhibiting a relative excess of power. On the other hand, volatile fluids, having a high boiling-point, say 140° Fah. or higher, and which produce no effect until they make the round of the circulation, tell first upon the heart, and break the balance on the circulating side. Ether and chloroform, respectively, are perfect representatives of these two classes of volatile fluids.

There are other volatile substances which, producing by their inhalation an immediate action on the nervous expanse, paralyze the heart instantaneously when inhaled in sufficient quantity, and lead to instant pallor of lung, and often to rupture of the vesicles. Nitrite of amyl is a striking substance of this class.

Substances soluble in the blood act differently, according to their primary effect, on the heart or the muscles of respiration. Tobacco paralyzes the heart first, and breaks the balance on the circulating side. Opium and aconite paralyze the respirating mechanism first, and break the balance on the respirating side.

Under alcohol the balance holds with remarkable smoothness after the first stage of intoxication is established. In the first stage the cardiac overaction takes the lead, and the respirating overaction follows. Were it not for this, every attack of alcoholic intoxication would be followed by pulmonic congestion. As it is, this danger is generally escaped, except in very hot and in very cold weather. In hot weather the escape is more difficult, because the heat aids the alcohol in quickening the action of the heart; in cold weather the escape is equally difficult, because under the influence of the cold the pulmonic function is reduced in power. Thus, from heat and cold, under alcohol, we may have similar results, congestion and congestive pneumonia, a fact which my experiments with alcohol, under varying conditions of heat and cold, singularly and systematically exhibited.

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